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(54) Abstract Title
Shelling cashew nuts using a laser

(57) The decortication of fruit or nuts, in particular cashew nuts, includes the steps of cutting through the pericarp of the fruit or nuts with at least one laser and thereafter removing the pericarp from the body of the fruit or nut. Two or more lasers may be used. The fruit or nut and the or each laser are rotated relative one to the other in order that the pericarp may be cut through without damaging the body of the fruit or the kernel of the nut. The fruit or nut may rotated bodily whilst the or each laser is held in a fixed position, in the alternative the fruit or nut is held in a fixed position whilst the or each laser is rotated thereabouts. Also, the fruit or nut may be constrained to follow a linear path between two laser beams.

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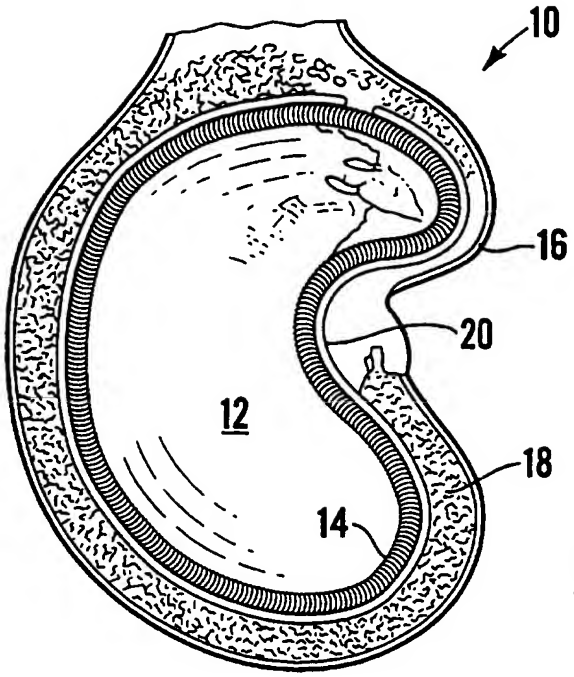

Fig. 1

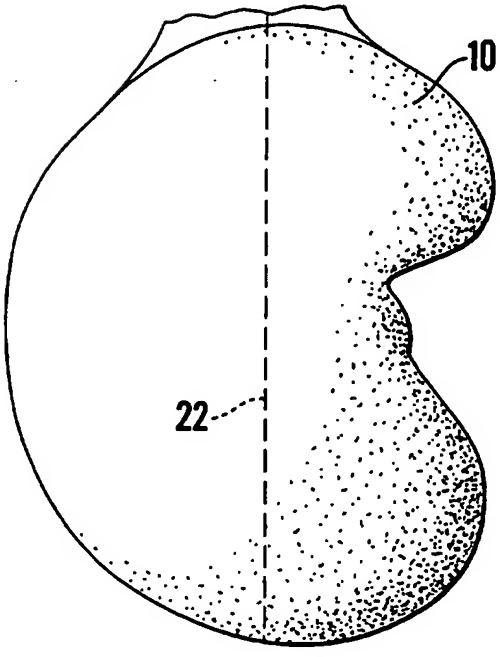

Fig. 2

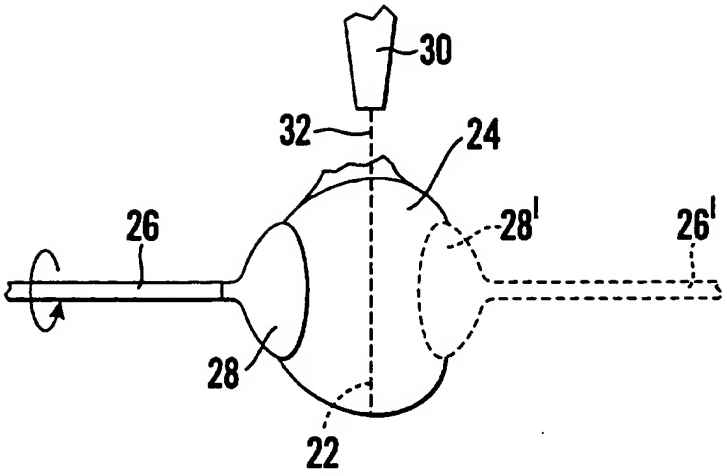

Fig.3

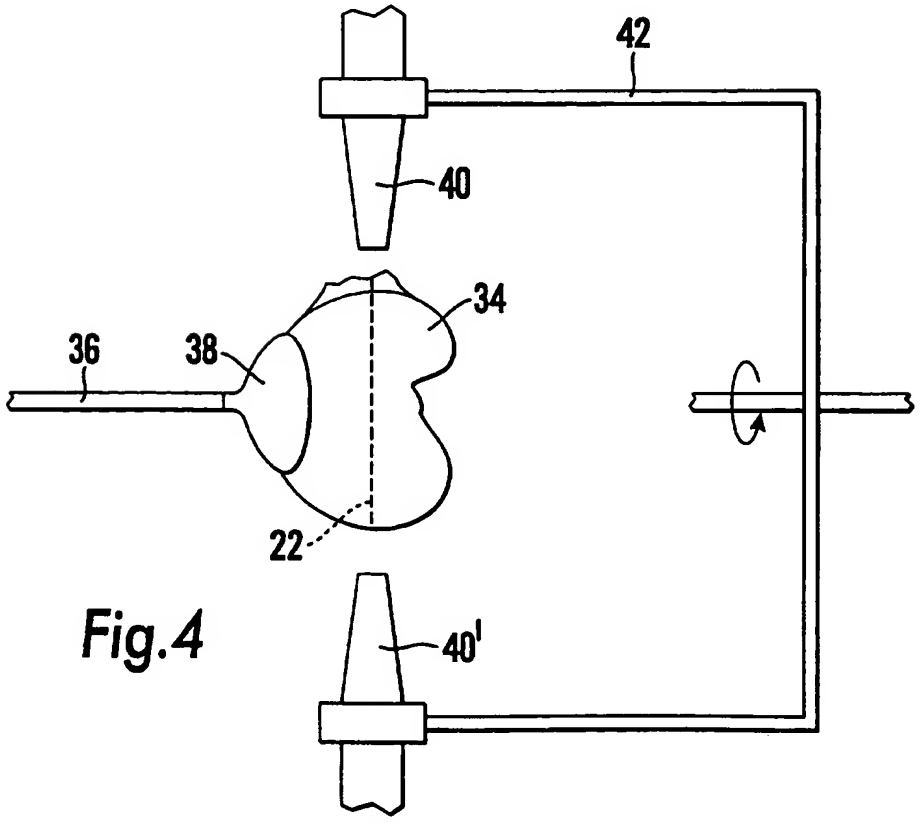

Fig.4

DECORTICATION OF FRUITS

DESCRIPTION

The present invention relates to the decortication of fruits, more particularly but not exclusively, of nuts.

Many fruits have a pericarp, an outer skin or shell, which is difficult to remove from the body of the fruit, for example the kernel of a nut, without damaging that body or kernel.

It is particularly difficult, for example, to decorticate cashew nuts. This difficulty arises principally because the kernel of nut with its surrounding testa tends to wholly fill the pericarp or shell of the nut. Another difficulty arises in that the shell or

pericarp of the cashew nut contains an oil - cashew nut shell liquid (CNSL) - which blisters human skin unless precautions are taken and will spoil the kernel of the nut if allowed to contact it.

Typical processing systems for cashew nuts at present are known as the dry roast, wet roast and steam processing systems.

In each of these systems the nuts are first harvested and then sun dried from approximately 25% to 9% moisture content. This renders the nut stable and safe for storage. At this point the product is known as raw cashew nut and is marketable. Before further processing raw cashew nuts are graded for size and any bad nuts are rejected. In the dry and wet roast system, raw cashew nuts require re-humidification to approximately 16% moisture content before exposing the nuts to heat. The purpose of this is to make kernels elastic, and provide them with a degree of protection from high temperatures, and help prevent scorching.

In the dry roast system the nuts are then roasted over a fire. This embrittles the shells of the nuts which are thereafter quenched with water. The nuts are then shelled by hand or mechanical means (for example using crackers or microsaws) to enable the kernels with their testa, to be removed from the broken shell parts.

The kernel is dried at about 60-70°C enabling the

testa to be loosened and the testa is then peeled from the kernel. The kernels are graded manually and packaged.

The wet roast system differs from the dry roast system in that after humidification to a level of about 16% moisture the cashew nuts are roasted in a bath of hot CNSL which embrittles the shell. In doing this part of the natural CNSL in the cashew nut shell passes to the bath (about 25%) and the remaining liquid on the outer shell is removed with a drying agent such as sawdust. The embrittled shell may then be mechanically cut or broken to allow the kernel to be removed. The kernel is then again dried further at about 60 - 70°C, (to about 6% moisture content) the testa removed from the kernel and the graded kernels packaged and made ready for despatch.

In the known steam process the harvested nuts are again dried to about 9% moisture content, cleaned and stored and then graded. They are steamed for approximately 20 minutes (depending upon size) and then dried for between 16 and 72 hours.

The nut shells which have in this way been embrittled are then broken using hand crackers enabling the kernel to be taken from the broken shell. Again the kernel is allowed to dry at between 60 - 70°C until the testa is sufficiently loose to enable it to be peeled from the kernel. Once again the kernels are graded and sent off for packaging.

These traditional cashew nut processing systems have not changed for many years. All the processes involve a number of stages and a high degree of product handling. As noted the cashew nut shell liquid (CNSL) is a major problem during processing. It can in each of the noted processes contaminate the kernel which makes the kernel of lower value. Contact of this liquid with human skin will also cause damage to the individual handling it.

Cashew nut kernel is a very high value product. Premium prices (US$5-8/kg) are paid on the world market for good quality whole white kernel. Discounting the small percentage of nuts damaged by insects or disease every nut has the potential of producing a whole white kernel - demanding premium prices. With the known traditional processes, however, only 30% of whole white kernel is achievable. All other grades of, damaged, kernel are of less value and require a significantly high degree of manual sorting to enable them to be turned into a saleable product.

Objects of the present invention includes the provision of a method, process and apparatus for alleviating and/or overcoming the difficulties found with the known processes for decorticating fruits, in particular cashew nuts.

In a first aspect the invention provides a method of decorticating fruit comprising the step of cutting

through the pericarp of the fruit making use of a laser and thereafter removing the pericarp from the body of the fruit. This method is of particular advantage in decorticating nuts, in particular cashew nuts. A method embodying the invention therefore provides the steps of holding the cashew nuts and cutting through the shell of the nut making use of a laser. In the method of the invention two or more lasers may be used.

Desirably, the fruit or nut and the or each laser are rotated relative one to the other in order that the pericarp may be cut through without damaging the body of the fruit or kernel of the nut.

The fruit or nut may be rotated bodily whilst the or each laser is held in a fixed position. Alternatively, the fruit or nut may be held in a fixed position whilst the or each laser is rotated thereabouts. Alternatively nuts may take a linear path between two laser beams. Also in any laser application, the focal point of the or each laser may follow the nut contour in a controlled way.

In particular when decorticating cashew nuts it has been traditional to attempt to break or cut through the shell of the nut in the plane lying between the cotyledons of the kernel.

With advantage we now propose that the cashew nut be cut using one or more lasers in a plane extending generally normally of the plane between the cotyledons.

It is believed that the traditional method of cutting through the shell of the cashew nut means that as the parts of the shell are prised apart they will tend to cause the cotyledons of the kernel to split along the natural cleavage line between them.

In a second aspect the present invention provides a process for decorticating cashew nuts which comprises the steps of drying the nuts after they have been harvested, cleaning and storing the nuts, grading the nuts, using ~~a~~ one or more lasers to cut the shell of the nuts, splitting the shells of the nuts and picking out the kernel, drying the kernel, peeling the testa from the kernel and thereafter grading the kernel and packaging the nuts.

A particular advantage of the process now proposed is, it is believed, that the cut through the shell of the cashew nut made with laser beams acts to seal the cut edges of the shell - preventing the egress of cashew nut shell liquid therefrom. In this way the CNSL is retained within the parts of the shell, does not leak out to damage the kernel of the nut or anybody handling the nut thereafter.

After cutting the shell of the cashew nut any suitable means may be used to prise the shell halves from the nut. For example a wedge may be used in order that the shell halves are manually driven apart.

If, however, the cashew nut is held between

support members, e.g. two suction members or a mechanical clamping device, for rotation to enable the shell to be cut with the laser(s) it is possible that retraction of the two support members can be used to pull the halves of the shell from the kernel.

In a third aspect the present invention provides apparatus for carrying the above method and process the apparatus comprising a laser and means for supporting a cashew nut within the beam of the laser such that the laser may be used to cut the shell of the nut.

The apparatus may provide that the laser is fixed in space and the cashew nuts are driven in rotation within the beams of the laser. In the alternative the apparatus may provide that the cashew nut is fixed in space and that the laser is movable thereabouts such that its beam cuts the shell of the cashew nut.

It will be appreciated that two or more lasers may be used in conjunction to cut the shell of a single cashew nut.

The above aspects, features and advantages of the present invention will become more apparent from the following description of arrangements embodying the invention now made with reference to the accompanying drawings in which:-

Figure 1 illustrates a cashew nut,

Figure 2 illustrates the line of the cut proposed

to be made by the method, process and apparatus of the present invention,

Figure 3 illustrates apparatus for putting the method in process of the invention into effect, and

Figure 4 illustrates an alternative apparatus embodying the invention.

Figure 1 illustrates a section through a cashew nut having a shell or pericarp 10 surrounding a kernel 12 separated from the pericarp by a testa 14. Pericarp 10 includes an epicarp 16, a mesocarp 18 and an endocarp 20. The pericarp, and in particular the mesocarp 18 contains a high level of cashew shell liquid (CNSL) which is highly corrosive but, it must be noted, is of particular high value commercially.

The traditional method of decorticating cashew nuts would be to split the pericarp 10 in the plane of the drawing of Figure 1. It will be noted, however, from Figure 1, that in this plane the pericarp 10 is of variable thickness about the cashew nut.

In accordance with the present invention it is envisaged that the pericarp 10 will be split along the line 22 shown in Figure 2 - that is to say in a plane substantially at right angles to the plane traditionally used. It has been found by experimentation that in this plane the thickness of the pericarp 10 is significantly less variable.

Figure 3 shows one form of apparatus for effecting the method and process of the invention and in particular shows the cashew nut 24 held supported for rotation on a rod 26.

The cashew nut 24 is held on the end of the rod 26 by means of a suction pad 28 which is evacuated after nut 24 has been brought into contact with it such that nut 24 is firmly held. If desired a second rod 26' provided with a suction pad 28' may also be used to support the cashew nut 24. It will be noted that the axes of rotation of the rods 26 and 26' are coincident.

Rods 26 (and 26' if provided) are driven in rotation as indicated by the arrow R. Located above the cashew nut 24 is a laser 30 the beam of which (as indicated at 32) is directed to the surface of the cashew nut 34.

It will be appreciated that rotation of the rod 26 (and 26' if provided) will enable the beam 32 of the laser 30 to follow a continuous loop about the shell of the cashew nut in the plane indicated at 22 in Figure 2.

After sufficient time has been allowed for the beam 32 to cut through the shell of the cashew nut 24 the laser 30 is de-activated.

It will be appreciated the suction pads are merely one way of supporting the nuts and that in some circumstances, for example when the surface texture of the nut makes the use of suction pads unsuitable, any form of

mechanical clamping device may be used.

Figure 4 illustrates a second form of apparatus embodying the invention which shows a cashew nut 34 supported on a fixed rod 36 by means of a vacuum pad 38. A second rod (not shown) may be provided if desired to support the second side of the cashew nut 34 making use of a second vacuum pad. In this arrangement the rod 36 is fixed in space and the apparatus further includes a pair of lasers 40, 40' held in a rotatable frame or cradle 42. The beams of the laser 40 40' are indicated generally on diametrically opposed sides of the cashew nut 34 and are rotatable within the cradle 42 such that their beams sweep across the surface of the cashew nut shell enabling that shell to be cut.

We have found that the average thickness of the pericarp 10 of the cashew nut in the plane indicated in Figure 2 is approximately 2mm.

In rotating the nuts at approximately 250RPM and making use of a Howden Laser MF 400 continuous wave Co2 laser with a TEM00 output beam type and an output lens of 14mm zinc selenide of 48mm focal length and using lens and nozzle cooling by compressed air, it is possible to cleanly cut through the pericarp of a cashew nut if the outer surface of the pericarp is between 2 and 5mm from the nozzle of the laser and if the nut is held within the laser beam for between 1 and 2 seconds. It will be appreciated

that other forms of laser may be used and gases other than air may be used for cooling purposes.

The particular laser utilised, and it will be appreciated that others may be used if desired, is relatively inefficient in terms of energy generation and generates a considerable volume of waste heat. It is envisaged that this waste heat will be used to help dry the kernels after decortication to ease the removal of the testa therefrom.

It is envisaged at this stage that in using the method and apparatus proposed at least 10kg or more cashew nuts per hour can be cut. This production rate should yield 2kg of high quality whole nut kernel per hour. Thus a simple hand fed laser machine working an eight hour day would process approximately 80kg of nuts yielding 16kg of high quality whole kernel. A single nut/laser application has been described. This may be multiplied up within one machine to increase the capacity. A single laser beam output may be split to accomplish this, or multiple laser units can be installed.

In distinction to this a typical hand cracker can process up to 100kg of cashew nuts in an eight hour day yielding a total of 20kg of kernel. Of this 20kg of cashew nut kernel, however, only about 6kg will be whole and the remaining 14kg will be degraded and worth, at most, half of the whole kernel.

As noted above the use of the laser to cut the shell of the cashew nut appears to seal within the shell the cashew nut shell liquid. After decortication of the nut the shell parts may be removed for abstraction of the high quality CNSL therein - a valuable by-product of the cashew nut decortication process.

It will be appreciated that many modifications may be made to the described arrangements without departing from the scope of the invention which essentially provides that cashew nuts and other fruits, may be decorticated making use of a laser to cut through the pericarp of the fruit allowing the pericarp to be removed from the body of the fruit or nut without damage to that body.

Claims

1. A method of decorticating fruit or nuts comprising the steps of cutting through the pericarp of the fruit or nuts with at least one laser and thereafter removing the pericarp from the body of the fruit or nut.

2. A method as claimed Claim 1, wherein two or more lasers are used.

3. A method as claimed Claim 1 or Claim 2, wherein the fruit or nut and the or each laser are rotated relative one to the other in order that the pericarp may be cut through without damaging the body of the fruit or the kernel of the nut.

4. A method as claimed in Claim 3, wherein the fruit or nut is rotated bodily whilst the or each laser is held in a fixed position.

5. A method as claimed in Claim 3, wherein the fruit or nut is held in a fixed position whilst the or each laser is rotated thereabouts.

6. A method as claimed in Claim 3, wherein the fruit or nut is constrained to follow a linear path between two laser beams.

7. A method as claimed in any one of the preceding claims, wherein the focal point of the or each laser follows the contour of the fruit or nut in a controlled way.

8. A method as claimed in any one of the preceding

claims, of decorticating a cashew nuts using one or more lasers the beams of which lie in a plane extending generally normally of the plane between the cotyledons of the nut.

9. A process for decorticating cashew nuts which comprises the steps of drying the nuts after they have been harvested, cleaning and storing the nuts, grading the nuts, using ~~a~~ one or more lasers to cut the shell of the nuts, splitting the shells of the nuts and picking out the kernel, drying the kernel, peeling the testa from the kernel and thereafter grading the kernel and packaging the nuts.

10. A process as claimed in Claim 9, wherein the cashew nut is held between two support members for rotation to enable the shell to be cut with the laser(s) and wherein retraction of the two support members is used to pull the parts of the shell from the kernel.

11. A process as claimed in Claim 10, wherein the support members comprise suction pads or a mechanical clamping device.

12. Apparatus for use in the method of claim 1, the apparatus comprising at least one laser and means for supporting a cashew nut within the beam thereof such that the shell of the nut is cut.

13. Apparatus as claimed in Claim 12, wherein the or each laser is fixed in space and the cashew nuts are driven in

rotation within the beams of the laser.

14. Apparatus as claimed in Claim 12, wherein the cashew nut is fixed in space and that the or each laser is movable thereabouts such that shell of the nut is cut.

15. A method of decorticating fruit or nuts as claimed in Claim 1 and substantially as herein described.

16. A process as claimed in Claim 9 and substantially as herein described.

17. Apparatus as claimed in Claim 12 and substantially as herein described.